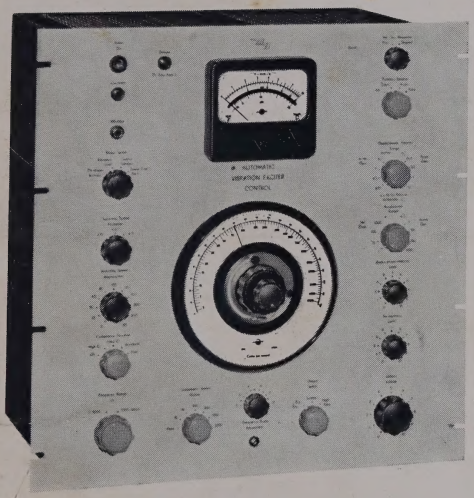
SERVICE MANUAL



N 572

Brüel & Kjaer

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Automatic Vibration Exciter Control

Type N 572

JANUARY 1961

Contents

General 3
Technical Description 3
Description of the Oscillator and Output Amplifier Section 3
Description of the Vibration Meter Section (Regulating Amplifier) .. 8
Description of the Frequency Sweep Unit 14

Checking and Adjustment Procedures 16
General 16
Initial Instrument Check 16
Adjustment of Oscillator Section and the Instrument Meter 20
Adjustment of the Regulating Amplifier Section 21
Fault Tracing 25
Oscillator Section 25
Regulating Amplifier Section 29

Major Component Location Charts 31

General.

The Automatic Vibration Exciter Control Type N 572 is a relatively complex oscillator and control system. It consists basically of a beat-frequency oscillator, a frequency sweep unit, a vibration meter, an automatic amplitude control and an automatic displacement-acceleration transfer unit. Whenever the instrument is taken out of operation for servicing or adjustment it should be handled with great care, and should not be re-installed in an actual vibration test system, until a complete check has indicated that the instrument functions properly.

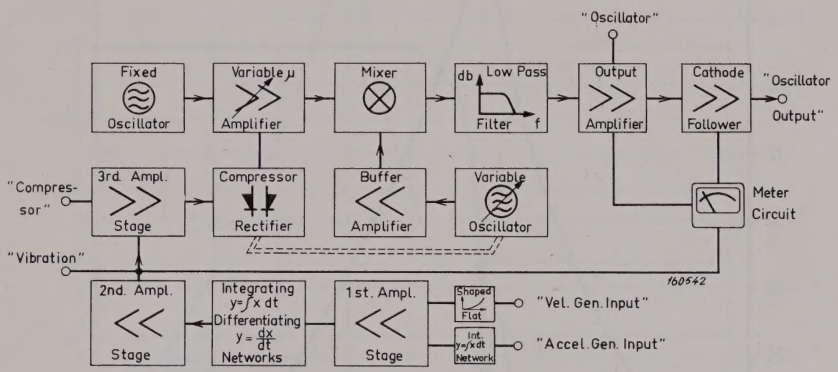

Fig. 1. Block diagram of the N 572 Automatic Vibration Exciter Control.

Technical Description

Description of the Oscillator and Output Amplifier Section.

Fixed Oscillator. The oscillator is built according to the heterodyne principle using two oscillators, one of which operates on a fixed frequency, while the frequency of the other can be varied with a variable capacitor. The fixed oscillator is tuned to 35 kcps and is, when the Vibration Exciter Control is switched to the lower of its two frequency ranges, paralleled by an extra capacitor. The frequency is thereby changed to 30 kcps.

Variable μ-Amplifier. The output voltage from the fixed oscillator is fed to the grid circuit of a pentode, the grid bias of which is con-

trolled by means of the regulating amplifier. The pentode stage is thus working as a variable μ-amplifier. The purpose of this circuit is to automatically control the output voltage of the Vibration Exciter Control by an A. F. control voltage from a vibration pick-up mounted on the shaker table (or from the signal generator coil).*)

Band-Pass Filter. To ensure a low distortion of the output signal from the variable μ-amplifier, a band-pass filter in the form of two inductively coupled circuits is inserted in the anode circuit of the pentode, Fig. 2.

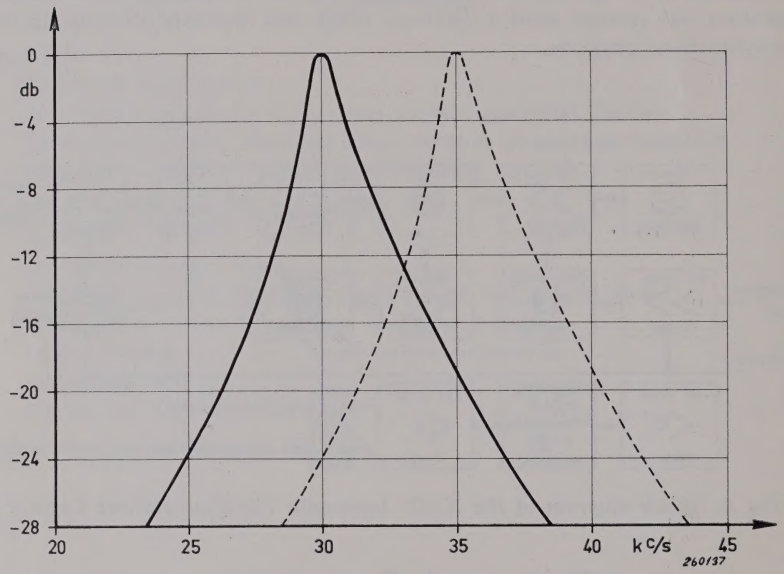

Fig. 2. Typical frequency characteristic of the band-pass filter in the variable μ-amplifier.

Variable Oscillator. The frequency of the variable oscillator can be altered continuously from 30 to 25 kcps by means of a specially designed variable capacitor. This capacitor is made with a high degree of accuracy, and a maximum deviation of 0.7 degrees from a logarithmic frequency curve is obtained. In the grid circuit of the variable oscillator is inserted two variable capacitors (one coarse and one fine) for adjustment of the Exciter Control frequency scale. From the

*) Signal generator coil = velocity type pick-up.

Mixer. oscillator the variable frequency signal is fed to the buffer amplifier, which is included to prevent undesired feed-back. The signal is then, together with the signal from the variable μ-amplifier fed to the mixer tube, this being of the triode type, thereby providing a low hum level in spite of the AC heating of the filament.

Low-Pass Filter. In the anode circuit of the mixer tube a low-pass filter with a cut-off frequency of 12 kcps is inserted, thus passing only the lower frequency obtained from the frequency conversion into the output amplifier section, see Fig. 3. The voltage from the low-pass filter is then fed to the control grid of the first tube in a two-stage low frequency amplifier. A switch inserted in the anode circuit

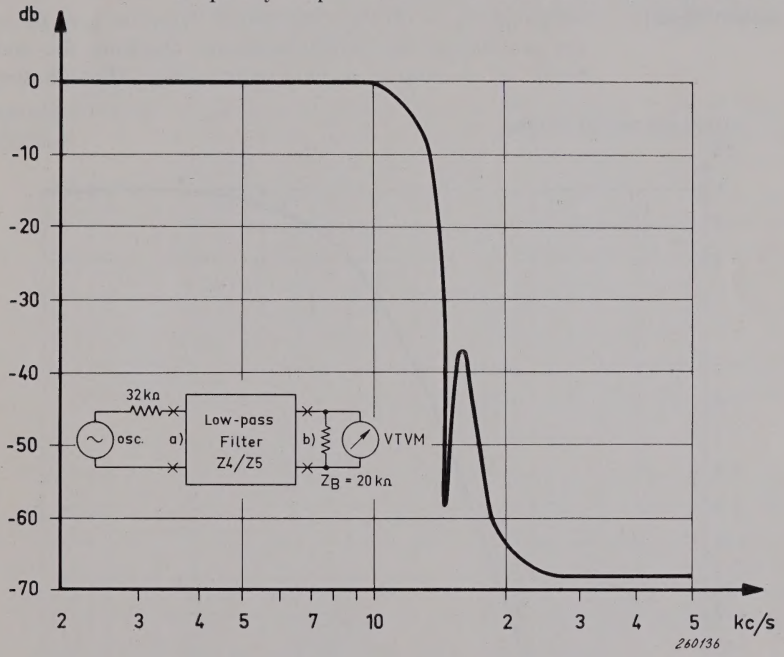

Fig. 3. Typical frequency characteristic of the low-pass filter in the oscillator section of the N 572.

Low-Frequency Amplifier. of the second tube of this amplifier and marked "Output Switch" allows the following functions to be performed:—

(1) It connects the low frequency amplifier to a cathode-follower output stage via a variable potentiometer ("Output Voltage"), or

(2) it connects the L. F. amplifier to the cathode-follower output via the "Output Voltage" potentiometer *and* a high-pass filter (Fig. 4), or

(3) it disconnects the L. F. amplifier from the cathode-follower.

External Oscillator. The last position of the "Output Switch", (3), enables an external oscillator, or programmed tape recorder, to be connected to the cathode-follower instead of the N 572 oscillator, the "Output Voltage" potentiometer being paralleled by a terminal marked "Oscillator" on the front panel.

Monitoring or Control Signal. When the "Output Switch" is in any of the two first positions (1) or (2), the "Oscillator" terminal may be used for monitoring the N 572 oscillator, checking the waveform, or controlling an externally connected stroboscope.

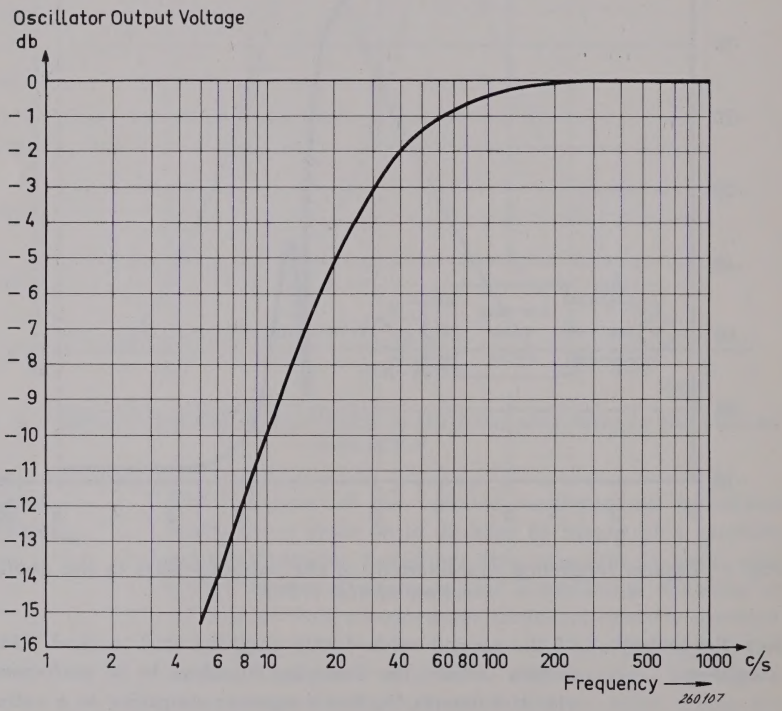

Fig. 4. Typical frequency characteristic of the high-pass filter in the oscillator section of the N 572.

High-Pass Filter. The high-pass filter may be inserted when vibration tests are carried out at a constant displacement level. The function of the filter is to extend the level range in which full regulation can be obtained for sudden changes in table load. This can be readily understood from the following. When the Vibration Exciter Control is switched to maintain a constant displacement level on the shaker table its output voltage must increase with frequency. If this steady increase in output voltage should only be taken care of by the regulating amplifier, the level range in which a sudden decrease in vibration level could be regulated back to the normal level would decrease as the frequency increases. The high-pass filter in the oscillator output circuit will, however, automatically provide an output voltage increase of approximately 6 db per octave up to frequencies around 25 cps.

Protection Circuit Resetting. In conjunction with the "Output Voltage" potentiometer a control circuit for the protection of the power amplifier and shaker has been included. The circuit consists of a relay controlled by a switch, the latter being built as one unit with the "Output Voltage" potentiometer and operated by the same control knob. If, for any reason, the shaker-amplifier combination is turned off by one of its protection arrangements, the test cannot be continued until the "Output Voltage" knob has been turned to zero and the shaker-amplifier thereby switched into operation again by means of the relay control unit. The relay contacts are connected to the terminal marked "Reset Switch" on the rear of the N 572.

The switch on the "Output Voltage" potentiometer also operates the red "Danger" lamp on the top left of the instrument front panel. This lamp will light as soon as the potentiometer is turned up (and the compressor circuit switched on). An external "Danger" lamp may also be connected to two of the contacts in the "Reset Switch" terminal for remote warning.

Output Circuit. From the "Output Voltage" potentiometer the oscillator signal is fed to the cathode-follower stage for impedance transformation. The voltage "loss" in this stage is approximately 0.5 db and the output is available at the terminal marked "Oscillator Output" on the rear of the instrument. The maximum output voltage is around 10 Volts, and the

"Oscillator Output" terminal should be loaded by a maximum of 10 kΩ.

A built-in indicating meter can, by means of the "Meter Switch", be connected to measure both the output from the L. F. amplifier and the output from the cathode follower.

Description of the Vibration Meter Section (Regulating Amplifier).

Input Circuit. The Vibration Meter Section contains a regulating amplifier with vibration level controls, it also includes an indicating meter and a rectifier circuit which supplies the control signal for the servo (compressor) arrangement of the oscillator's automatic gain control. The unit can be controlled from an accelerometer or a velocity type vibration signal. Two separate inputs are available marked "Acceleration Generator Input" and "Velocity Generator Input", respectively. The inputs are situated on the rear of the instrument.

Range Switches. Two range switches on the instrument front panel marked "Displ.-Vel. Range" and "Acceleration Range" contain two sections each, one section being for use with an accelerometer and one for use with a velocity type pick-up. A further switch marked "Function Selector" determines which type of regulation (constant displacement, constant velocity or constant acceleration) actually takes place.

Accelerometer Control. If an accelerometer is used as the controlling element it should be connected to the input marked "Accel. Gen. Input" via a high-quality preamplifier (see Instruction Manual, p. 17 and 23). From the input terminal the signal is fed to the two prior mentioned range switches and to the input tube of the 1st Amplifier Stage via a relay operated by the "Function Selector" switch. In conjunction with the "Accel. Gen." section of the "Displ.-Vel. Range" switch a first integration of the accelerometer output signal takes place.

Velocity Pick-up Control. Should a velocity type pick-up be used as the controlling element it should be connected to the input marked "Vel. Gen. Input". The signal is then fed to the "Function Selector" switch via a switch marked "Vel. Gen. Response" on the front panel.

Shaping Network. When the "Vel. Gen. Response" switch is in position "Shaped" an R. C. Shaping

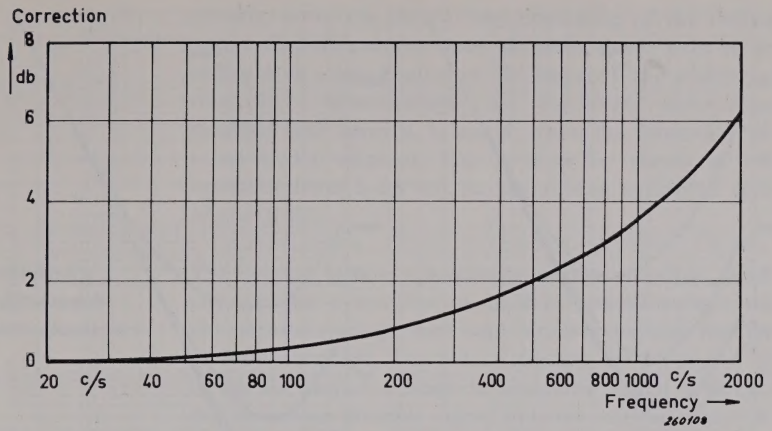

Fig. 5. Typical frequency characteristic of the RC compensation network in the velocity generator input circuit of the N 572 vibration meter section.

network, which compensates for the variation in frequency characteristic of the MB vibration pick-ups (Model 124 and 126) is connected in circuit (Fig. 5). When in position "Flat" the shaping network is by-passed. From the "Function Selector" switch the signal is fed to the range switches and the input tube of the 1st Amplifier Stage.

1st Amplifier Stage.

The 1st Amplifier Stage is a conventional R-C coupled amplifier stabilized by means of a mixed voltage-current feedback. Due to the great dynamic range required from the amplifier an extensive smoothing and stabilization of the DC voltages has been found necessary.

Integrating and Differentiating Networks.

Following the amplifier are the integrating and differentiating circuits necessary for the vibration meter section to perform its various functions. A number of stabilizing networks have been inserted at this point to avoid low-frequency instability.

Stabilizing Network.

Figs. 6, 7, 8, and 9 show the frequency characteristics of the 1st Amplifier Stage (including the integrating network in the output circuit) when the N 572 is switched for displacement control. It can be seen that the sensitivity of the stage at 5 c/s is 40 db higher than the sensitivity at 50 c/s. Operating at frequencies around for example 2000 c/s a small low-frequency disturbance may conse-

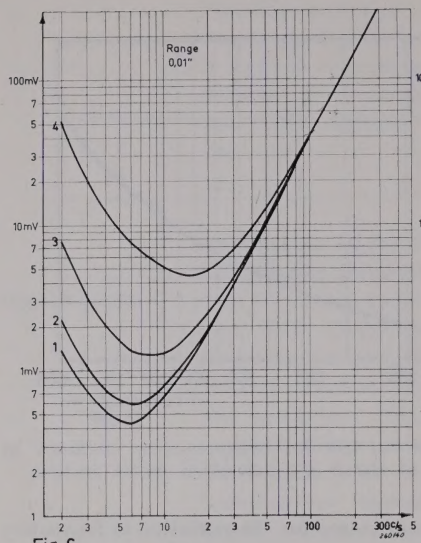

Fig. 6

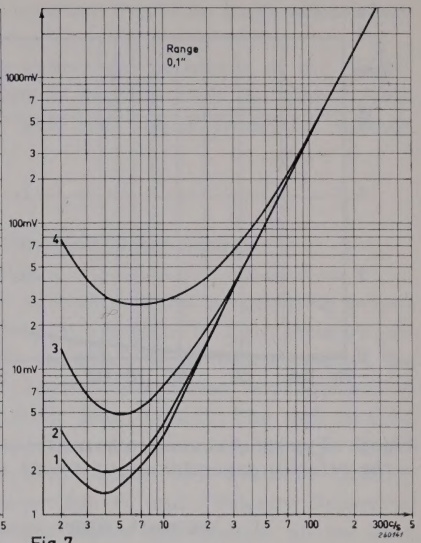

Fig. 7

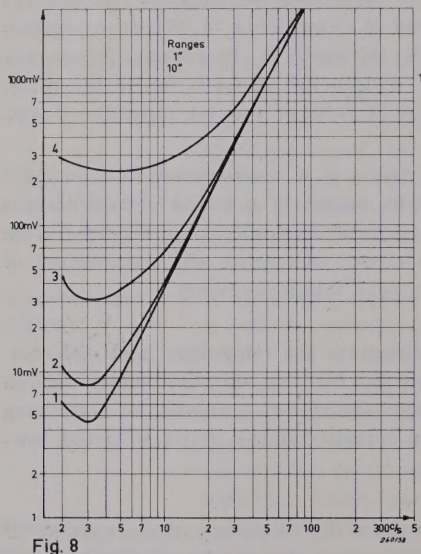

Fig. 8

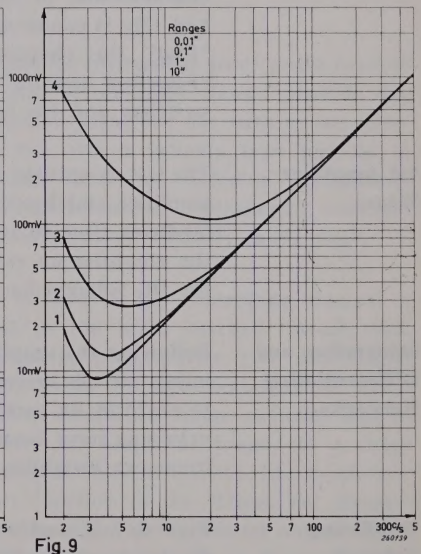

Fig. 9

Fig. 6, Fig. 7, and Fig. 8. Typical sensitivity characteristics of the vibration meter section (including stabilizing networks) when the instrument is switched for displacement measurements by means of an accelerometer. The characteristics indicate the input voltage necessary to produce full-scale meter deflection for the various measurement ranges.

Fig. 9. Typical "inverse" frequency characteristics of the vibration meter section (including stabilizing networks) when the instrument is switched for displacement measurements by means of a velocity type pick-up.

quently cause the closed loop consisting of the oscillator power amplifier-shaker and vibration meter with servo to oscillate at a low frequency. To improve the stability, the frequency characteristic is therefore automatically changed into curve 2, 3, and 4, when the frequency range is upwardly scanned. This is done by means of relays operated from a switch on the tuning capacitor spindle of the N 572.

Sensitivity Adjustment Potentiometers. The correct absolute sensitivity of the vibration meter is adjusted by a number of built-in potentiometers which are screwdriver-operated and situated on top left (rear) of the instrument. The potentiometers are connected within the 1st Amplifier Stage in a manner which ensures that the maximum possible signal-to-noise ratio is obtained for the vibration meter.

2nd Amplifier Stage. From the 1st Amplifier Stage and the differentiating and integrating network the signal is fed to the 2nd Amplifier Stage, which, similar to the 1st Amplifier Stage, contains a pentode and a triode section. The stage is R-C coupled and supplied with mixed voltage-current feedback. To further improve the stability of the N 572 against low-frequency disturbances the amplifier is designed to provide a sharp cut-off at 5 cps. The cut-off frequency is raised to 10 cps when the "Displ.-Vel. Range" switch is in the positions "o.1 inch (o.25 cm) - Accel. Gen." and o.01 inch (o.025 cm) - Accel. Gen." by means of a R-C phase changing network.

Low-Frequency Cut-off.

Protection Diode. A diode is connected in the control grid circuit of the second tube and makes certain that no undesired blocking of the amplifier takes place, even when, by accident, too great signals are applied to the vibration meter input. (Blocking of the amplifier might cause complete damage to the shaker and test specimen).

Continuous Vibration Level Controls. The output signal from the second amplifier stage may, by means of the switch marked "Meter Switch", be fed direct to the meter which then indicates the vibration level. Between the second and the third amplifier stage are inserted the potentiometers marked "Displacement-Velocity Level" and "Acceleration Level" for continuous regulation of the vibration level, as well as the terminal on the front

panel marked "Vibration", and the "Compressor" terminal at the rear of the instrument. The "Vibration" terminal is intended for waveform checking or recording of the vibration level by means of a level recorder and can be loaded by an impedance of 100 kohms or more. The "Compressor" terminal allows the connection of protective devices to safeguard the shaker and power amplifier. It also allows the insertion of special shaping networks to be used when sweep vibration tests have to be performed according to some particular vibration amplitude vs. frequency characteristic.

3rd Amplifier Stage.

The third amplifier stage consists of an ordinary amplifier and phase inverter, the output voltage of which is rectified in a double diode, quasi-RMS type rectifier. The time constant of the rectifier circuit is made variable, and the rectified voltage is used to control the working point of the variable μ-amplifier in the oscillator circuit, thus regulating the oscillator output voltage. By changing the time constant of the rectifier filtering networks, the speed with which regulation of the Automatic Vibration Exciter Control output takes place can be varied. This is carried out employing the switch marked "Compressor Speed", where regulation speeds of approximately 10—30—100—300—1ooo or 3ooo db/sec. are available. The regulation speed is, furthermore, a function of the amount of feedback (the compression).*)

Automatic Variation of Compressor Speed.

During vibration tests the highest possible regulation speed should be used to prevent dangerous vibratory amplitudes in the system from being built up. However, when working at low frequencies and high compressor speeds, the compressor tends to regulate the waveform of the sinusoidally varying output signal from the Automatic Vibration Exciter Control, which causes distortion of the signal. For this reason a position marked "Auto" has been incorporated in the "Compressor Speed" switch. With the switch in this position the regulation speed is automatically increased when the frequency of the N 572 output signal is increased. The regulation speed is varied in steps and changing from one speed to the next takes place at 30,

*) (For further information regarding the dynamic regulation the reader is referred to the Brüel & Kjær Technical Review No. 2 - 1958).

100, 300, 1ooo and 3ooo cps. The switching is performed by means of relays and is controlled by a switch mounted on the tuning capacitor spindle. (The same switch also controls the relays of the previously mentioned stabilizing networks).

To allow different regulation speeds for different specimen Q's a "Compressor Function" switch is included in the circuit. This switch has five positions marked "Off", "High Q", "Med. Q", "Standard" and "Fast". When the switch is in position "Off" the servo (compressor) is switched out of use, and the instrument operates as a separate driving oscillator and vibration meter. With the switch in any other position various regulation speed vs. frequency characteristics are obtained as listed below:

Frequency cps	30	100	300	1ooo	3ooo	5ooo
"High Q"	10 db/sec			30 db/sec	100 db/sec	300 db/sec
"Med. Q"	10 db/sec		30 db/sec	100 db/sec	300 db/sec	1ooo db/sec
"Standard"	10 db/sec	30 db/sec	100 db/sec	300 db/sec	1ooo db/sec	3ooo db/sec
"Fast"	30 db/sec	100 db/sec	300 db/sec	1ooo db/sec	3ooo db/sec	

Table showing the regulation speed of the automatic compressor as a function of frequency and the position of the "Compressor Function" switch.

Harmonic Distortion. The maximum harmonic distortion of the output signal from the N 572 is approximately 1 % for frequencies above 10 cps when the "Compressor Function" switch is in the "Standard" position. When in the "Fast" position the distortion is appreciably greater and when in the "High Q" and "Med. Q" positions the distortion is lower.

Precharging Capacitors in Compressor Regulation Circuit. The circuits employed to achieve the automatic compressor operation are, as previously mentioned, controlled by relays, which switch the capacitors in the rectifier filtering network in or out of circuit, thereby changing the servo time constant (regulation speed). To avoid any disturbing transient phenomena taking place during the switching process, the capacitors to be connected, must be precharged to the same voltage level as the capacitors already in the

active circuit.*) It has been found necessary to perform the precharging in two steps. All capacitors except those in the active circuit, and the one which is to be connected next, are precharged to a certain voltage level, close to the correct one. The charging time constants of this "1st step" are great and cannot quickly follow variations in the vibration level. The capacitor which will be connected next, when the "Compressor Speed" is switched to a lower position, is charged to exactly the correct voltage level and the charging time constant allows it to follow variations in the vibration level with approximately the same speed as the capacitors connected in the active circuit.

Since an increase in time constant (decrease in compressor speed) is obtained by simply adding capacity in the rectifier filtering network, the above described precharging arrangement is only necessary, to allow the compressor speed to be decreased without upsetting the proper function of the test set-up. An increase in compressor speed is obtained by disconnecting capacity from the active circuit, no voltage level changes taking place.

Automatic Cross-over, Displacement to Acceleration and Vise Versa.

A further arrangement, which should be mentioned in connection with the regulating amplifier, is the automatic cross-over arrangement which allows constant displacement operation of the vibration test set-up to take place below the cross-over frequency and constant acceleration operation above the cross-over frequency. It consists of a number of relays, which are operated by a cam disc contact arrangement. The cam disc is mounted on the tuning capacitor spindle, and can be adjusted to any frequency between 10 and 500 cps. The automatic cross-over takes place when the "Function Selector" switch of the N 572 is in position "Auto", and is indicated by the lamp on the top right of the front panel marked »Acceleration". This lamp will light whenever the instrument is switched for constant acceleration operation.

Description of the Frequency Sweep Unit.

Motor Control Circuit.

The motor in the Automatic Vibration Exciter Control is a small squirrel-cage motor with four poles, which two-by-two are connected in series. The two pole-pairs are again

*) By "active circuit" is here meant the circuit which actually determines the servo time constant (compressor speed).

connected to the power supply in parallel, with a phase-shift capacitor in series with one of the pole-pairs. The reversing switch switches this series capacitor from the one pole-pair to the other and in this way reverses the rotation of the motor. The approximate 1460 r.p.m. of the motor is by means of a mechanical gear reduced to $\frac{350}{360}$ r.p.m. of the capacitor spindle. By means of the switch marked "Scanning Speed Multiplier", a magnetic clutch operated gear with a transmission factor of 1 : 10 may be switched in. To adjust the scanning speed in smaller steps, an adjustable DC current is fed to the four magnetizing coils. With respect to the DC-current, the motor is working as a short-circuited DC generator, and a braking torque is produced. The DC current is adjustable by means of a variable series resistor marked "Scanning Speed" degrees/min.

Spark Absorbers. All the switching contacts in the frequency sweep unit are, in addition, supplied with spark absorbers to prevent the development of electrical pulses which would be picked up by the compressor amplifier and cause false regulation to take place.

Checking and Adjustment Procedures

General.

Whenever the internal adjustments of the Automatic Vibration Exciter Control Type N 572 have been accidentally touched, or the instrument has been taken out of use for servicing or maintenance, a check and readjustment of the controls should be undertaken.

NOTE:

Ensure that the special plug supplied with the instrument upon delivery is inserted in the "Compressor" socket on the rear of the instrument before a check or vibration test is set-up.

Initial Instrument Check.

Before the instrument is installed in a vibration test system the following "quick check" is recommended:

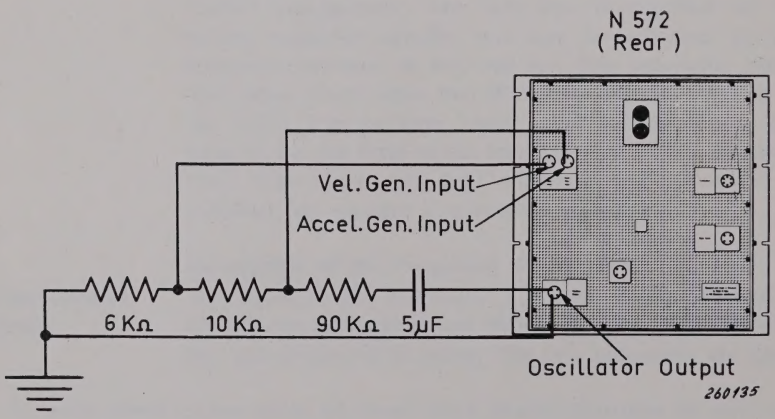

Fig. 10. N 572 connected for checking purposes.

1. Calibrate the Oscillator frequency scale as described on p. 15 in the "Instruction Manual" for N 572 provided separate from this text.
2. Turn the knobs marked "Displacement-Velocity Level" and "Acceleration Level" to "0".
3. Connect the oscillator output to the input terminals marked "Velocity Generator Input" and "Acceleration Generator Input" as shown in Fig. 10.

High-Pass Filter.

4. Set "Meter Switch" in position "Output Voltage".
5. Set "Scanning Speed Multiplier" to "Off".
6. Set "Compressor Function" to "Off".
7. Turn the oscillator frequency dial to 10 cps.
8. Set "Output Switch" to "Linear".
9. Turn the "Output Voltage" until full-scale deflection (20 db) is obtained on the instrument.
10. Set "Output Switch" to "High Pass". The meter pointer deflection should now be approximately 10 db.
11. Reset "Output Switch" to "Linear".
12. Set "Meter Switch" to "Oscillator Voltage". The meter pointer should now deflect fully clockwise (greater than full scale).
13. Turn the "Output Voltage" potentiometer fully counterclockwise until a small "click" is heard.
14. Set "Compressor Function" to "Standard".
15. Set "Compressor Speed" to "10 db/sec".
    (In this position the change in signal level takes place very slowly, which should be taken into account during the following adjustments.)
16. Set "Vel. Gen. Response" to "Flat".
17. Set "Function Selector" to "Displ.".
18. Set "Displacement-Velocity Range" to o.01 inch (o.025 cm)—"Vel. Gen.".
19. Turn the oscillator frequency dial pointer to 2ooo cps.
20. Turn the "Output Voltage" potentiometer slowly to maximum (red light "Danger—Do Not Switch" lights). The red lamp will remain lit when the potentiometer is in any position other than fully counterclockwise or the compressor is switched off. After a period the meter pointer deflection appears below 20 db.
21. Turn the knob marked "Displacement-Velocity Level" clockwise until the instrument meter pointer points at 20 db.

Constant Displacement, Velocity Generator Control.

22. Turn the oscillator frequency dial pointer counterclockwise and check the instrument meter reading at the following frequencies:

2ooo cps	1ooo cps	500 cps	250 cps	125 cps
20 db	14 db	8 db	2 db	—4 db (appr.)

23. Turn the "Displacement-Velocity Level" clockwise until the instrument meter pointer deflects again to 20 db.
24. Continue to turn the oscillator frequency dial pointer counterclockwise and check the meter reading at the frequencies:

125 cps	50 cps	20 cps	10 cps
20 db	12 db	4 db	—2 db (approx.)*)

25. Turn the oscillator frequency dial pointer to 1ooo cps.

Constant Displacement, Accelerometer Control.

26. Set "Displacement-Velocity Range" to o.01 inch (o.025 cm) - "Accel. Gen." and adjust the "Displacement-Velocity Level" potentiometer until the meter pointer deflects to 12 db.
27. Turn the oscillator frequency dial pointer to 500 cps and check that the meter pointer deflects to 0 db.
28. Set "Displacement-Velocity Range" to o.1 inch (o.25 cm) - "Accel. Gen." and check the meter reading at the following frequencies:

500 cps	250 cps	125 cps
20 db	8 db	—4 db (approx.)

29. Set "Displacement-Velocity Range" to 1 inch (2.5 cm) - "Accel. Gen." and check the meter reading as follows:

125 cps	50 cps
16 db	0 db

30. Set "Displacement-Velocity Range" to 10 inches (25 cm) - "Accel. Gen." and check

50 cps	20 cps	10 cps
20 db	4 db	—8 db (approx.)

31. Turn the oscillator frequency dial pointer to 1ooo cps.

Cross-over.

32. Set the "Acceleration Range" switch to 100 g - "Accel. Gen." and the "Function Selector" to "Accel.". The lamp marked "Accel." on the top right of the instrument will now light.
33. Turn the "Acceleration Level" potentiometer slowly clockwise until the instrument meter pointer deflects to 12 db.
34. Set the "Displacement-Velocity Range" switch to 1 inch (2.5 cm) - "Accel. Gen.".

*) These values are not exact due to the finite steepness of the regulation curve.

35. Turn the oscillator frequency dial pointer counter-clockwise to 100 cps. The meter pointer deflection should not change during the variation of frequency.

36. Set the "Function Selector" to "Auto".

37. Keep the oscillator frequency dial pointer in its position, i.e. at 100 cps, and adjust the cross-over frequency by turning the outer knob on the tuning capacitor spindle until the "Accel." lamp just goes out (or lights up). The meter indication should be approximately the same (12 db) on "both sides" of the cross-over frequency (100 cps). Readjustment can be made by "Displ. Vel. Level". Check that the meter pointer deflection falls off at a rate of 12 db/octave below cross-over. (Approximate meter pointer deflection at 50 cps is 0 db).

Constant Acceleration, Velocity Generator Control.

38. Set the "Acceleration Range" switch to "10 g - Vel. Gen." and turn the oscillator frequency dial clockwise. At the cross-over frequency (100 cps) the meter pointer deflection will "jump" to approximately 15 db. Check that the deflection decreases at a rate of 6 db/octave with increasing frequency. (At 200 cps the meter pointer deflection should be approximately 9 db).

Constant Velocity, Velocity Generator Control.

39. Set the "Displacement-Velocity Range" switch to position 1 inch (2.5 cm) - "Vel. Gen." and set "Function Selector" to "Vel.". The meter pointer should deflect to around 6 db. Check that the meter indication does not change with frequency from 5 cps up to 2000 cps. Maximum allowable deviation $\pm$ 0.2 db.

40. Keep frequency at 2000 cps and set "Vel. Gen. Response" to "Shaped". The meter pointer deflection should now be approximately 0 db.

Shaping Network for Velocity Generator.

41. Turn the oscillator frequency dial pointer counter-clockwise and check the meter reading at the following frequencies. Adjust possible deviation from 0 db by "Displ. Vel. Level".

2000 cps	700 cps	300 cps	50 cps
0 db	3.5 db	5 db	6 db

Keep frequency at 50 c/s.

42. Reset "Vel. Gen. Response" to "Flat".

43. Set the "Acceleration Range" switch to "100 g - Accel. Gen." and the "Function Selector" to "Accel.". The meter pointer should now deflect to approximately 12 db.

Constant Acceleration, Acceleration Generator Control.

44. Turn the oscillator frequency dial pointer to 5ooo cps and then counterclockwise to 10 cps. The meter pointer deflection should not vary more than ± 4 % during the variation of frequency.
45. Set the "Frequency Range" switch to "5005—10ooo" cps and turn the oscillator frequency dial pointer clockwise to 5ooo. The variation in meter pointer deflection should be approximately 1 db during the variation of frequency.

Compressor Speed.

46. Turn the "Compressor Speed" switch successively to 30—100—300—1ooo and 3ooo db/sec., and back again to 10 db/sec. The counterclockwise switching of the "Compressor Speed" knob should be carried out slowly due to the time constants in the capacitor charging circuits (see chapter Technical Description, p. 13, of this booklet). During the switching the meter pointer indication should not deviate from its original deflection.
47. Reset "Frequency Range" to "5—5ooo" cps.

Adjustment of Oscillator Section and the Instrument Meter.

To adjust the oscillator output voltage the two 20 kΩ screwdriver-operated potentiometers P2 and P3 are used, see schematic diagram. These items are located under the bottom chassis of the instrument, refer Fig. 11.
The output and input terminal connections of the instrument should be disconnected and the terminals left open. Set the control knobs according to the following scheme:—

1. "Meter Switch" in position "Output Voltage".
2. "Scanning Speed Multiplier" to "Off".

Output Voltage from Oscillator Section.

3. "Frequency Range" to "5—5ooo".
4. "Compressor Function" to "Off".
5. Set the oscillator dial pointer to 5ooo cps. A precision vacuum-tube voltmeter is connected across R 21. The potentiometer P 2 is adjusted until a reading of 300 mV is obtained on the VTVM.
6. Set the "Frequency Range" to 5005—10ooo cps.
7. Turn the oscillator frequency dial pointer to 5 (i.e. 5005 cps).
   The potentiometer P3 is adjusted until voltage across R 21 is 300 mV.

8. The precision VTVM is connected to the "Oscillator Output" terminals and the "Output Voltage" potentiometer is adjusted until the external VTVM shows exactly 10 Volts.

Calibration of Indicating Meter. By means of Potentiometer P 12, Fig. 11, adjustment is carried out so that the built-in voltmeter also shows exactly 10 Volts.

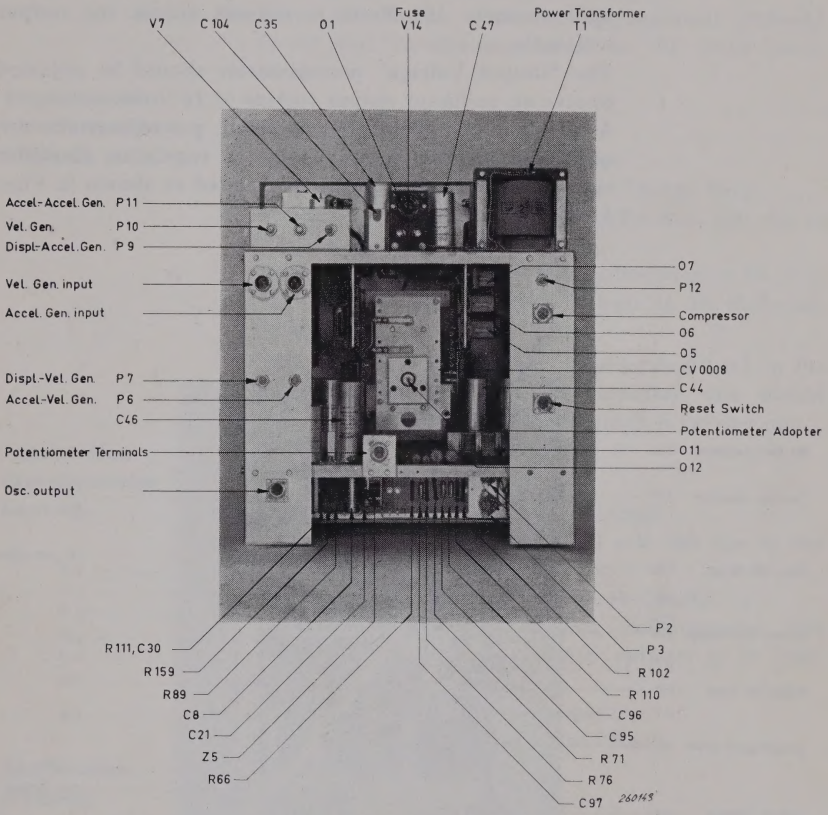

Fig. 11. Rear view of the N 572.

Adjustment of the Regulating Amplifier Section.

The oscillator section of the Automatic Vibration Exciter Control can be used for the adjustment of the regulating amplifier section. However, for accurate adjustment a precision VTVM is required for proper regulation of the voltage and a frequency counter for frequency scale

setting. Prior to the adjustment, the oscillator section should be calibrated as described under "Adjustment of the Oscillator Section and the Instrument Meter", p. 20. Set the "Compressor Function" in position "Off" and connect the "Oscillator Output" to the input marked "Vel. Generator Input" via a suitable voltage divider. A capacitor (approx. 5 μF) should be connected between the oscillator output and the voltage divider as a DC voltage of approximately 100 Volts is present across the output terminals.

The "Output Voltage" potentiometer should be adjusted to give an oscillator output voltage of 10 Volts.

A number of screwdriver-operated potentiometers are used to adjust the sensitivity of the regulating amplifier section. The potentiometers are located as shown in Figs. 11 and 12.

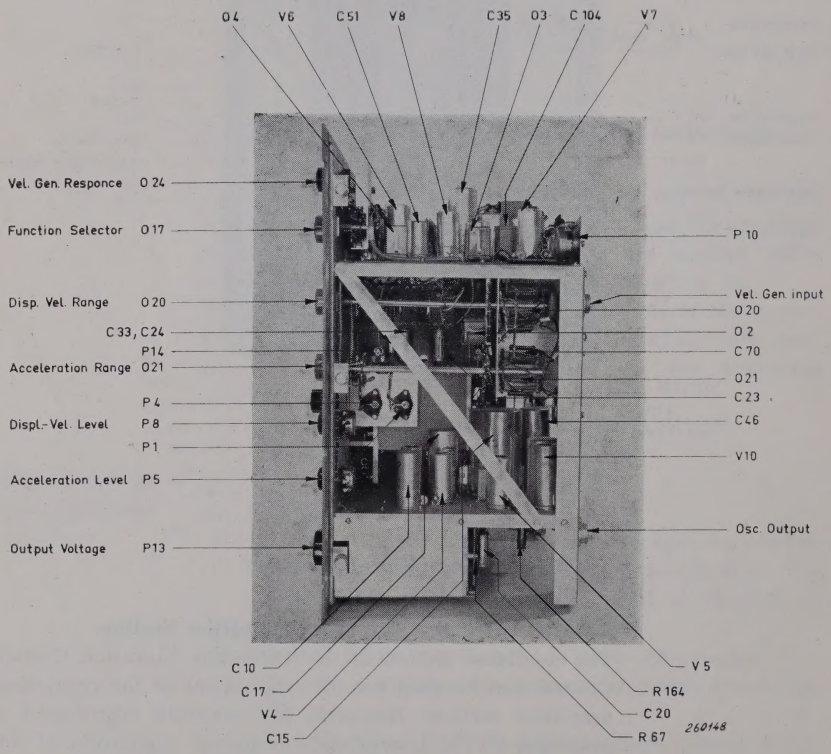

Fig. 12. Left side view of the N 572.

96.3 MV/IN/SEC

Calibration of Velocity Generator and Accelerometer Circuit.

For adjustment proceed as follows:—

1. Set "Meter Switch" to "Vibration Level".
2. Set "Scanning Speed Multiplier" to "Off".
3. Set "Frequency Range" switch to "5—5000" cps.
4. Set "Compressor Function" to "Off".
5. Turn the knobs marked "Displacement Velocity Level" and "Acceleration Level" to "10" (fully clockwise).

Displacement (Accelerometer Control).

6. Set "Function Selector" to "Displ.".
7. Set "Displ.-Vel. Range" to "0.01" "Accel. Gen.".
8. Apply a voltage of exactly 904 mV r.m.s., 500 cps to the "Accel. Gen." input.
9. Turn the screwdriver-operated potentiometer P9 (Fig. 11) until the meter pointer deflects to 10 (full-scale deflection).

   Note: Since P 9 controls the negative feed-back in the first stage of the regulating amplifier, this should always be the first adjustment which is carried out.

Acceleration (Accelerometer Control).

10. Set the "Function Selector" to "Accel.".
11. Apply a voltage of exactly 7.07 mV 500 cps to the "Accel. Gen. Input".
12. Set "Acceleration Range" to "Accel. Gen." "1 g".
13. Turn the screwdriver-operated potentiometer P11 (Fig. 11) until the meter pointer deflects to 10 (full-scale deflection).
14. Disconnect the "Accel. Gen. Input".
15. Set the "Vel. Gen. Response" to "Flat".

Acceleration (Velocity Generator Control).

16. Apply a voltage of exactly 8.36 mV 500 cps to the "Velocity Gen. Input".
17. Set "Acceleration Range" to "Vel. Gen." "1 g".

Displacement (Velocity Generator Control).

18. Turn the screwdriver-operated potentiometer P6 (Fig. 11) until the meter pointer deflects to 10 (full-scale deflection).
19. Set "Function Selector" to "Displ.".
20. Set "Displ.-Vel. Range" to "0.01" "Vel. Gen.".

21. Apply a voltage of exactly 1070 mV r.m.s. 500 cps to the "Vel. Gen." input.
22. Turn the screwdriver-operated potentiometer P 7 (Fig. 11) until the meter pointer deflects to 10 (full-scale deflection).

Velocity (Velocity Generator Control).

23. Reduce the voltage applied to "Velocity Gen. Input" to exactly 6.81 mV.
24. Set the "Function Selector" to "Velocity".
25. Turn the screwdriver-operated potentiometer P10 (Fig. 11) until the meter pointer deflects to 10 (full-scale deflection).

3rd Amplifier Stage, Balance.

26. Turn the screwdriver-operated potentiometer P1 (see Fig. 12) until the AC voltage on the two anodes of V6 equal each other.

Adjustment of Integrating Network (Displacement by Accelerometer Generator).

27. Set "Function Selector" to "Displ.".
28. Set "Displacement-Velocity Range" to "1 inch" "Acc. Gen.".
29. Turn the frequency dial pointer to 20 cps.
30. Apply 80 mV approx. to the "Accel. Gen. Input".
31. Reduce the "Output Voltage" until the deflection on the meter is exactly 10 db.
32. Turn the frequency dial pointer to 5 cps.
33. Switch "Displacement-Velocity Range" to "10 inches".
34. Turn the screwdriver-operated potentiometer P14 (see Fig. 12) until the deflection is 13.6 db.

Adjustment of Automatic Compressor Speed Circuit.

35. Connect an external VTVM to the "Oscillator" jack on the front plate.
36. Turn the frequency dial pointer to 500 cps.
37. Set "Function Selector" to "Accel.".
38. Connect the "Oscillator Output" directly to the "Accel. Gen. Input".
39. Set "Accel. Range" to "Accel. Gen. 100 g".
40. Set "Compressor Function" to "Standard" and "Compressor Speed" on "3ooo db/sec".
41. Turn the "Output Voltage" knob to 0.
42. Read off the external meter.
43. Turn the "Output Voltage" knob up to 10.
44. Rotate the "Accel. Level" counterclockwise until the external meter deflects to a 50 db lower value than under item 42 above.
45. Turn the "Meter Switch" to "Vibration Level".
46. Switch the "Compressor Speed" slowly from 3ooo to 10 db/sec.
47. Adjust the screwdriver-operated potentiometer P4,

Fig. 12, until the "Vibration Level" shows no variation on switching the "Compressor Speed" from a higher value to a lower value, as described under point 46.

Fault Tracing.

If the instrument does not function according to its specifications, it should be taken out of operation and thoroughly checked. The following outlines a short guide to fault tracing:—

Oscillator Section.

Output Voltage.

With the "Oscillator Output" terminals left open and the "Compressor Function" switch in position "Off", the available output voltage should be checked. (Full-scale meter deflection = 10 Volts). The output voltage should increase by an amount of 10—12 db, when the "Compressor Function" switch is turned from its position "Off". These two quick tests will normally give an indica-

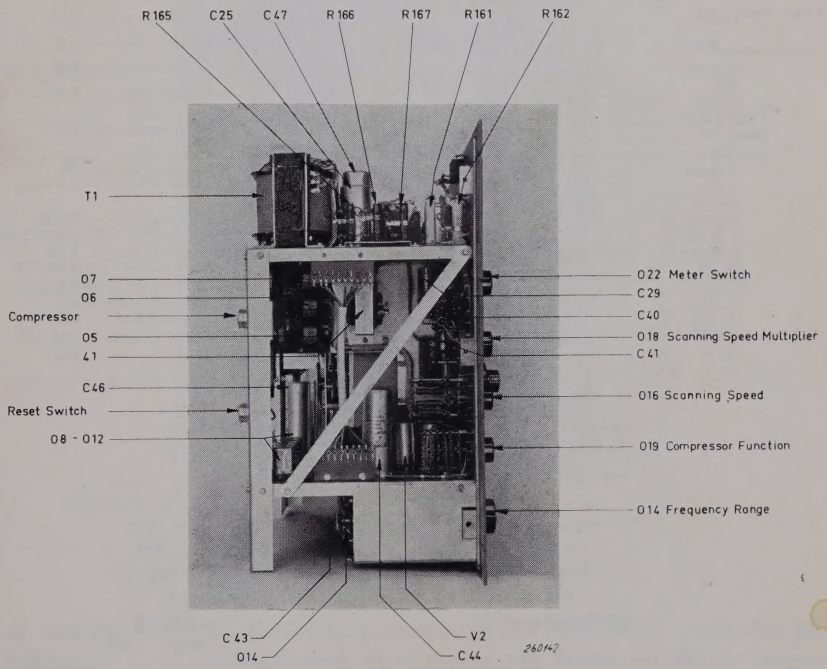

Fig. 13. Right side view of the N 572.

tion whether or not the oscillator section of the instrument is working properly. For further guidance it should be mentioned that the maximum signal-to-noise ratio should be higher than 60 db. The noise voltage can be measured with a VTVM connected across the "Oscillator Output" terminals with the tube V2 removed (Fig. 13). In case the noise voltage is higher than the allowed value, the mixer tube, a decoupling capacitor, or the low-pass filter (see schematic diagram) may not be functioning properly. If the frequency characteristic of the filter should be measured, it is necessary to employ an external audio-frequency oscillator connected between point "a" and

Signal-Noise Ratio.

Low-Pass Filter.

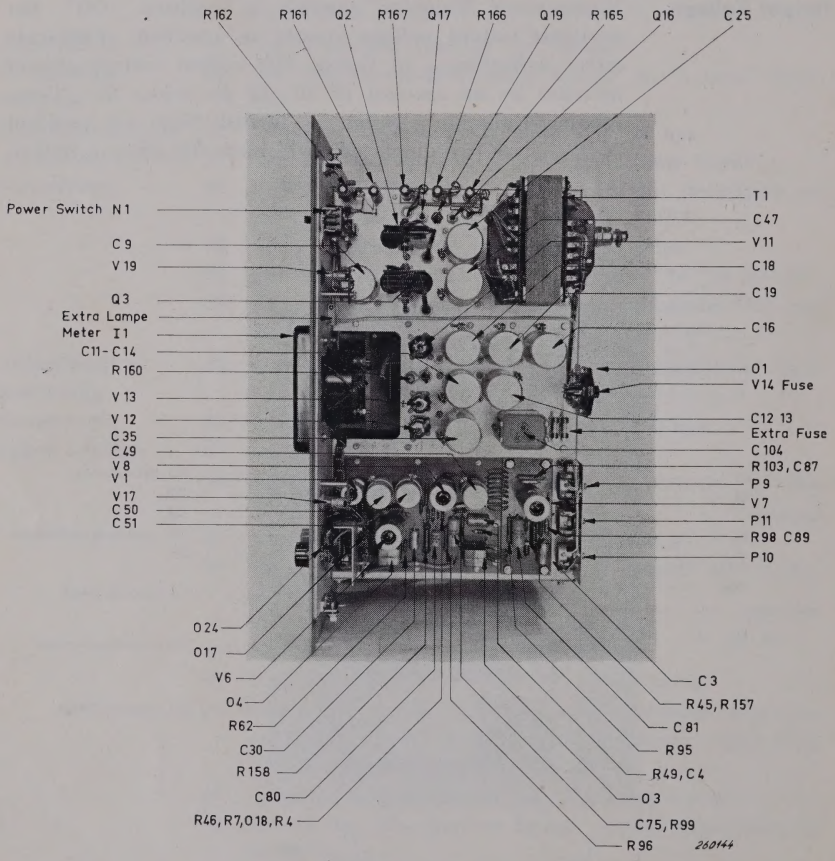

Fig. 14. Top view of the N 572.

ground, as well as a VTVM connected between point "b" and ground, see Fig. 3. The Automatic Vibration Exciter Control should be disconnected and the curve measured up to frequencies around 50 kcps.

Harmonic Distortion.

If the harmonic distortion measured at the output of the oscillator exceeds 0.5 % when loaded with a resistance of 10 kΩ, the tubes or the coupling or decoupling components may be defective, in addition, the condition of the band-pass filters in the anode circuit of tube V9 should be checked. A typical frequency characteristic of the filter is shown in Fig. 2.

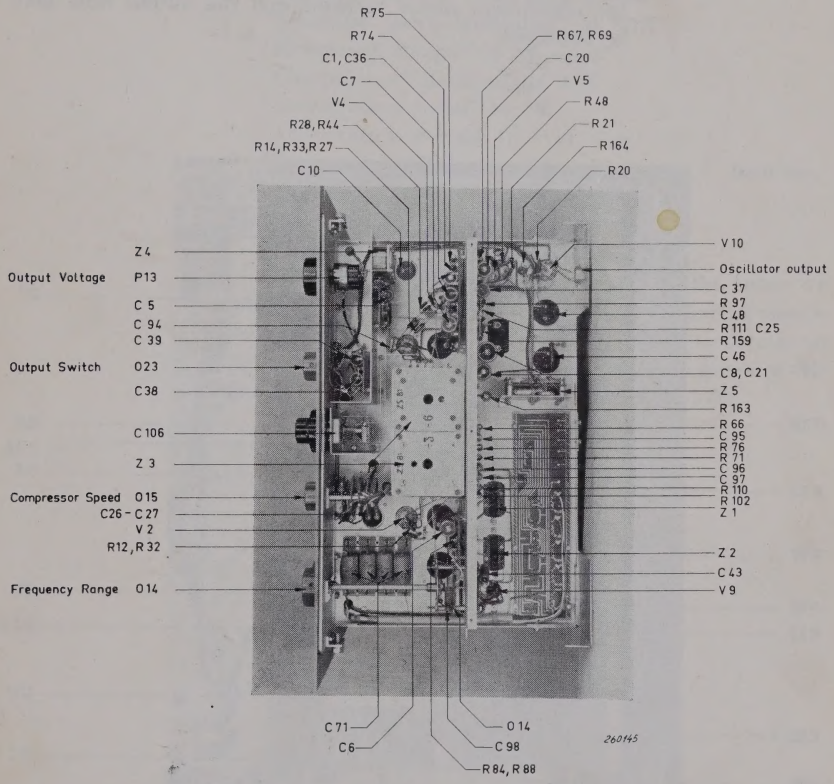

Fig. 15. Bottom view of the N 572.

AC and DC Voltages.

To facilitate servicing of the instrument, both the DC voltages and AC voltages are found on the schematic diagram, the DC voltages being marked around the tube

socket sketches. The voltage values are approximate values and tolerances as high as ± 20 % are to be expected. During measurements of the AC voltages the knob marked "Output Voltage" should be turned to maximum and the "Compressor Function" switch should be in position "Off". Tube locations are found on Figs. 11 through 15.

Note: Do not short-circuit the oscillator output voltage terminal as a voltage of approximately 100 Volts DC is present across the terminals. When the output voltage is measured by means of an external voltmeter, this must be borne in mind. By short-circuiting the output terminals, the instrument meter rectifier and the output tube may be damaged.

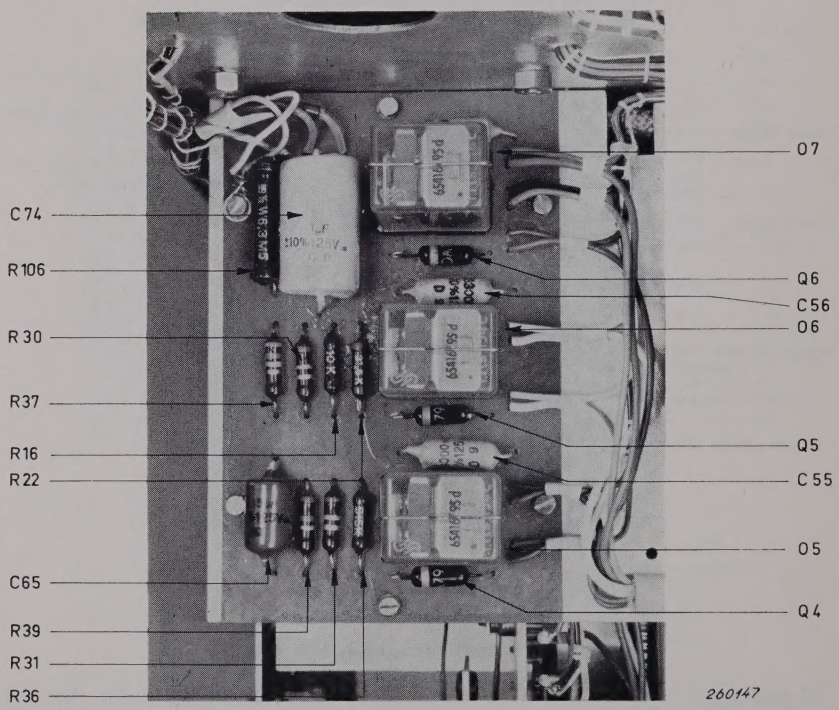

Fig. 16. Close-up view of the L.F.-cut-off relays.

Regulating Amplifier Section.

If the unit as a total does not function properly, and no faults are found when the oscillator section is checked, the voltages at different points in the regulating amplifier section should be measured, see schematic diagram.

The approximate AC voltages given on the schematics refer to the following operating conditions of the amplifier section:—

Input voltage applied to the "Velocity Gen." input terminals:—

6.81 mV (r.m.s.), 400 cps.

Setting of the control knobs:—

"Meter Switch" to "Vibration Level".
"Scanning Speed Multiplier" to "Off".
"Frequency Range" to "5—5ooo".
"Compressor Function" to "Off".
"Acceleration Level" to "0".
"Acceleration Range" to "Vel. Gen." "1".
"Displacement-Velocity Range" to "o.1 inch/sec." "Vel. Gen.".
"Function Selector" to "Vel.".
"Vel. Gen. Response" to "Flat".

To obtain the AC voltages marked around the tubes V6 (and V1) the "Displacement-Velocity Level" potentiometer should be adjusted until a voltage of 1 volt is present at the control grid of V6. (Can be measured at pin 1 of the "Compressor" terminal on the rear of the N 572).

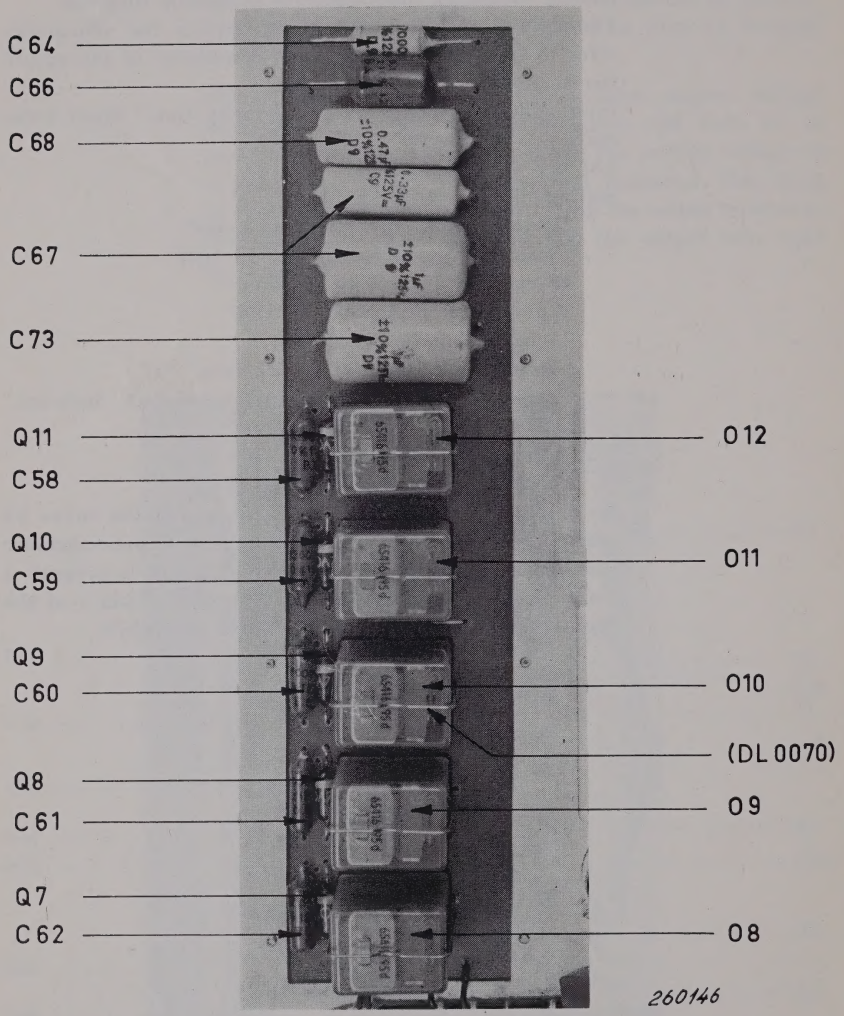

Fig. 17. Close-up view of the automatic compressor control relays.

MAJOR COMPONENT LOCATION CHARTS

Capacitors

Capacitor	Figure
C. 3	14
C. 5	15
C. 6	15
C. 7	15
C. 8	11
C. 9	14
C. 10	12
C. 11	14
C. 12	14
C. 13	14
C. 15	12
C. 16	14
C. 17	12
C. 18	14
C. 19	14
C. 20	12
C. 20	15
C. 21	11
C. 21	15
C. 23	12
C. 24	12
C. 25	13

Capacitor	Figure
C. 25	14
C. 25	15
C. 26	15
C. 27	15
C. 29	13
C. 30	11
C. 30	14
C. 33	12
C. 35	11
C. 35	12
C. 35	14
C. 36	15
C. 37	15
C. 38	15
C. 39	15
C. 40	13
C. 41	13
C. 43	13
C. 43	15
C. 44	11
C. 44	13

Capacitor	Figure
C. 46	11
C. 46	12
C. 46	13
C. 47	11
C. 47	13
C. 47	14
C. 48	15
C. 49	14
C. 50	14
C. 51	12
C. 51	14
C. 55	16
C. 56	16
C. 58	17
C. 59	17
C. 60	17
C. 61	17
C. 62	17
C. 64	17
C. 65	16
C. 66	17
C. 67	17

Capacitor	Figure
C. 68	17
C. 70	12
C. 71	15
C. 73	17
C. 74	16
C. 80	14
C. 81	14
C. 94	15
C. 95	11
C. 96	15
C. 96	11
C. 96	15
C. 97	11
C. 97	15
C. 98	15
C. 104	11
C. 104	14
C. 106	15

Resistors

Resistor	Figure
R. 4	14
R. 7	14
R. 12	15
R. 14	15
R. 16	16
R. 20	15
R. 21	15
R. 22	16
R. 27	15
R. 28	15
R. 30	16
R. 31	16
R. 32	15
R. 33	15
R. 36	16
R. 37	16
R. 39	16
R. 44	15
R. 45	14
R. 46	14
R. 48	15

Resistor	Figure
R. 62	14
R. 66	11
R. 66	15
R. 67	12
R. 67	15
R. 69	15
R. 71	11
R. 71	15
R. 74	15
R. 75	15
R. 76	11
R. 76	15
R. 84	15
R. 88	15
R. 89	11
R. 95	14
R. 96	14
R. 97	15
R. 99	14
R. 102	11
R. 102	15
R. 103	14

Resistor	Figure
R. 106	16
R. 110	11
R. 110	15
R. 111	15
R. 157	14
R. 159	11
R. 159	15
R. 160	14
R. 161	13
R. 161	14
R. 162	13
R. 163	15
R. 164	12
R. 164	15
R. 165	13
R. 165	14
R. 166	14
R. 167	13
R. 167	14

Valves & Fuses

Valves & Fuses	Figure
V. 1	14
V. 2	13
V. 2	15
V. 4	12
V. 4	15
V. 5	12
V. 5	15
V. 6	12
V. 7	11
V. 7	12
V. 7	14
V. 8	14
V. 9	15
V. 10	12
V. 10	15
V. 11	14
V. 12	14
V. 14	11
V. 14	14
V. 17	14
V. 19	14

Switches

Switch	Figure
O. 1	14
O. 2	12
O. 3	12
O. 3	14
O. 4	12
O. 4	14
O. 5	11
O. 5	13
O. 5	16
O. 6	13
O. 6	16
O. 7	11
O. 7	13
O. 7	16
O. 8	13
O. 8	17
O. 9	17

Switch	Figure
O. 10	17
O. 11	11
O. 11	17
O. 12	11
O. 12	13
O. 12	17
O. 14	13
O. 14	15
O. 15	15
O. 16	13
O. 17	12
O. 17	14
O. 19	13
O. 20	12
O. 21	12
O. 22	13
O. 23	15
O. 24	14

Potentiometers

Potentiometer	Figure
P. 1	12
P. 2	11
P. 3	11
P. 6	11
P. 7	11
P. 8	12
P. 9	11
P. 9	14
P. 10	11
P. 10	12
P. 10	14
P. 11	11
P. 11	14
P. 12	11
P. 13	15
P. 14	12
TRANSFORMER	
T. 1	13

Diodes

Diode	Figure
Q. 2	14
Q. 3	14
Q. 4	16
Q. 5	16
Q. 6	16
Q. 7	17
Q. 8	17
Q. 9	17
Q. 10	17
Q. 11	17
Q. 16	14
Q. 17	14
Q. 19	14
TUNED CIRCUITS	
Z. 1	15
Z. 2	15
Z. 3	15
Z. 4	15
Z. 5	11

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